Defense Standardization and Specification Program

SD-10

GUIDE FOR IDENTIFICATION AND DEVELOPMENT OF METRIC STANDARDS

MARCH 1990

SDMP

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
FOR PRODUCTION AND LOGISTICS
WASHINGTON, D.C. 20301-8000

FOREWORD

This Guide is issued to help in the identification and development of needed metric specifications and standards. The availability of needed metric documents is a prerequisite to the development of metric-based weapon systems and equipment. Thus, this document will assist the DoD and related activities in meeting the requirements of Section 5164, Metric Usage, of Public Law 100-418, the Omnibus Trade and Competitiveness Act of 1988. The document will be useful to DoD Program Managers, DoD Standardization Management Activities, Acquisition officials, Non-Government Standards Bodies, and Contractors. Task Group 5, Specifications and Standards, under the DoD Metric Transition Plan developed and coordinated the document. Special thanks are due to the Metric Committee of the Standards Engineering Society, which contributed to the development of this Guide.

Peter Yuracisin
Director,
Standardization and Data
Management

GUIDE FOR IDENTIFICATION AND DEVELOPMENT OF METRIC STANDARDS

1. Scope

This document provides a "how to" guide to the identification and development of needed metric standards and specifications. The guide does not cover metric practice, such as methods of converting and rounding, as addressed in ASTM E 380 and ANSI/IEEE 268. However, it contains a bibliography of metric practice guides giving this type of guidance. NOTE: It is not the intention that this document address topics that are in MIL-STD-1476A of 19 November 1986, Metric System Application in New Design, which provides guidance on how to design a system or equipment once a decision has been made to design it in metric.

2. Background

2.1. Public Law 94-168, "Metric Conversion Act of 1975", declares that the policy of the United States shall be to coordinate and plan the increasing use of the metric system. It also states that the metric system of measurement is defined as the International System of Units established by the General Conference of Weights and Measures as interpreted or modified for the United States by the Secretary of Commerce.

2.2. Public Law 100-418, the Omnibus Trade and Competitiveness Act of 1988, designates the metric system of measurement as the preferred system of measurement for United States trade and commerce and requires that all Federal agencies use the metric system of measurement by the end of FY 1992 to the extent economically feasible. In conformance with P.L. 100-418, the Department of Defense (DoD) Directive 4120.18 requires that all DoD activities adopt the metric system of measurement in all their activities consistent with security, operational, economical, technical, logistical, and safety requirements, and shall place emphasis on developing metric specifications and standards to support the development of defense systems, equipment, and materials. The directive further requires that all DoD standardization documents shall be reviewed for metric applicability and that the cognizant standardization activity shall identify those documents for which a metric version is needed.

3. Definitions.

The following definitions are taken from MIL-STD-961C. Almost identical definitions for standards are found in MIL-STD-962B.

3.1. Metric specification. Metric specifications have requirements given in rounded, rational, metric units, usually as a result of being originally developed in metric. The magnitudes expressed are meaningful and practical. Documents containing only electrical units which are used in both the metric and inch-pound systems (for example, volts, amps, and ohms) are classified as metric documents. Documents also containing dimensional interfaces must have these interfaces in metric sizes to be classed as metric documents. Metric specifications are developed for items to interface or operate with other metric items.

3.2. Inch-pound specification. Inch-pound specifications have requirements given in rounded, rational, inch-pound units, usually as a result of being originally developed in inch-pound. The magnitudes are meaningful and practical. Inch-pound specifications should include those with rounded, rational, inch-pound units only. NOTE: There have been instances where magnitudes expressed in metric units as a result of mathematical conversion from rounded, rational inch-pound units are given first (preferred units) with the rounded, rational inch-pound units given in parenthesis or in a non-preferred position. These specifications are inch-pound documents. Inch-pound specifications are developed for items to interface or operate with other inch-pound items.

3.3. Hybrid specification. A hybrid specification is one in which some requirements are given in rounded, rational metric units, and other requirements are given in rounded, rational inch-pound units. Hybrid specifications are often required for use in new designs where existing usable components must interface in a metric system.

3.4. Not measurement sensitive specifications. A not measurement sensitive specification is one in which application of the requirements does not depend substantially on some measured quantity. This type of specification can be used with either a metric system or an inch-pound system.

3.5. Soft conversion. A soft conversion is the process of changing a measurement from inch-pound units to equivalent metric units within acceptable measurement tolerances without changing the physical configuration of the item.

3.6. Hard conversion. A hard conversion is the process of changing a measurement from inch-pound units to non-equivalent metric units, which necessitates physical configuration changes of the item outside those permitted by established measurement tolerances. The term "hard conversion" is in general use in the United States,

although it is technically incorrect as applied to specific items because no "conversion" takes place. Instead, a new metric item requiring a new part identification is created to replace the customary item eventually. The new item is often referred to as being in "hard metric."

3.7. Metric units.

3.7.1. Metric units are a system of basic measures defined by the International System of Units based on "Le Systeme International d'Unites (SI)," of the International Bureau of Weights and Measures (IBWM). These units are described in ASTM E 380, Standard for Metric Practice, and ANSI/IEEE 268, Metric Practice. Another document which is required is FED-STD-376A, Preferred Metric Units for General Use by the Federal Government.

3.7.2. In the United States, in formal terms, the authoritative SI source document is National Bureau of Standards Special Publication 330, "The International System of Units (SI)". For use in the United States, this is the official English language translation approved by the IBWM of the IBWM publication "Le Systeme International d'Unites". Based on this publication and on authority of the P.L. 94-168, the U.S. Department of Commerce issued "The Metric System of Measurement" in the Federal Register on February 26, 1982, as the interpretation and modification of the SI for use in the United States.

4. When are Metric Standards and Specifications Needed?

Normally, there are two situations when the development of a metric document is needed: simply to put requirements in metric measurement units, and development of physical modules for international harmonization. With regard to the first, this can often be accomplished by soft conversion. With regard to the second, there are pressures in areas of international product standardization for use of metric modules. Before one decides on the development of a metric document, the purpose of the document must be determined. Decisions must be reached on which requirements in the document are metric, which are soft converted, and which are inch-pound.

4.1. Where Soft Conversion Should be Used. If the purpose is simply to put the requirements in metric language, a soft conversion is really the only needed change. The soft conversion can be in the form of (a) stating only the converted metric units in the requirements as substitutions for the inch-pound units, (b) stating the metric units in parenthesis after the inch-pound units in the

requirements or vice versa (see 5.0), or (c) giving a table of conversions and/or conversion factors and giving the requirements in only one system. Soft conversion should be used in the following circumstances:

a. The technologies addressed in the document are based on the inch-pound system internationally. Examples are most areas of electronic packaging and grid spacings, hydraulics, and tire rim sizes. Since the purpose of metric is usually to achieve international standardization or interoperability, rather than metrication per se, there is no need to have a hard conversion in these areas. Rather, the purpose is to include metric language, since these documents describing these products or processes are expressed in metric units in the other countries and in the international standards.

b. Free standing, or stand alone, items where interoperability or interfacing is not needed, and there is no need for international standardization. Examples are pens and pencils, many types of furniture, etc.

c. Items or processes where rounded, rational numbers are not usual in either system. In these cases, economic and technical considerations are balanced to achieve an optimal situation. Examples of these are anti-corrosion coating thicknesses, electrical insulation thicknesses, locations of components in electronic assemblies, etc.

d. Capacities or volumes such as fuels, paints, and other coatings. Metric hardware or equipment such as the LHX helicopter can be painted using gallons of paint rather than liters, and can be powered by gallons of fuel as well as liters.

e. Many test method and process standards. Adding equivalent metric dimensions will permit the direct use of scales, micrometers, gauges, and other instruments calibrated in either system of units. However, if the existing standards and test methods affect final physical configuration or performance requirements, careful consideration is needed in preparing metric standards.

4.2. When Hard Conversion is Needed. Hard conversion is often necessary when there is a need for international harmonization or to operate with metric hardware. New metric design standardization documents will generally be developed for:

a. Items which have universal application and which require standardization in order to provide metric components for designers of metric materiel.

b. Items such as wire sizes, screw thread forms, fasteners, tubing sizes, and dimension stock material used in new systems specified from the beginning in metric dimensions.

c. Those areas which specify existing system designs that are to be changed to permit the use of metric system standards, production machinery, raw materials, spare parts, and maintenance tools and for which the most cost effective set of such changes must be selected.

d. Items wherein a reduction in the ranges, types, styles, or classes or products will be facilitated by adoption of a family of metric items.

e. Items which are peculiar to the DoD and represent technological advances for operational application in new materiel.

f. Items which have a universal application or function and industry has now designed the items in the metric system of measurement.

New metric standardization documents will often supplement customary standardization documents and will not necessarily supersede them. As transition progresses, use of metric standardization documents will increase, while use of customary standardization documents will decrease.

4.3 When No Conversion is Needed.

a. Items which are becoming obsolete and the change to metric is not practical.

b. Items which will continue in use without modifications. No useful purpose will be served in translating inches to millimeters for such items, its spare parts, or the tools required to maintain them since production and maintenance will continue to use inch-pound system facilities and standards.

c. Items of very limited applications where costs of metric modules outweigh benefits.

d. Not Measurement Sensitive documents (some maintain that documents such as are listed under 4.1.c., 4.1.d., and 4.1.e. are not measurement sensitive; for purposes of this guide, it is felt that there will be many applications where users will want to use the metric equivalents).

4.4 Metric Approaches. The following approaches are possible in providing specifications and standards to support metric usage:

a. New parallel document. For very complex documents filled with many conversion-susceptible measurements, the logical method is to issue a new SI metric standardization document. Great care should be used to ensure that the new document is hard metric, and that equivalents are carefully selected. After that, the basic document and the metric document would be revised concurrently, until such time as the inch-pound document is no longer required and is cancelled.

b. Metric appendix. For less complex documents, or for very complex documents where retention of the original document number is considered necessary, a hard metric appendix could be prepared. The basic document would remain in inch-pound units and refer to the appendix for metric information. The appendix would refer to the basic document for technical features and cite only the metric equivalents, exercising care to ensure that equivalents are carefully selected.

c. Metric notes. For relatively simple documents with only a few measurement units, metrication may be handled by appropriate notes or by one or more footnotes.

d. Contract wording. Metric requirements can be inserted in contracts in lieu of development of metric specifications or standards.

4.5 Metric Values. As far as the individual quantity requirements contained in the document, there are two basic ways of arriving at practical and meaningful metric values in hard conversion:

a. Size substitution - simple replacement of standard inch-pound size with existing accepted metric size. This is often used to conform to internationally recognized metric modules. Use of preferred types and sizes and parts and materials, especially those of ISO and IEC should be encouraged. Alteration of international or foreign standards to fit domestic needs before adoption is sometimes necessary.

b. Adaptive conversion - a change from a rounded, rational inch-pound quantity to a rounded, rational metric quantity which is reasonably equivalent (as, for example, speed limits).

The decision on which to use must be based on knowledge, experience, and common sense. There is a need for addressing rationalization and variety reduction, and consideration of arithmetic or geometric series of sizes. It is desirable to use metric dimensions for physical interface in hybrid systems, except between inch-pound items.

5.0. Dual dimensions.

The use of both metric and inch-pound measurements on drawings or other pictorial illustrations to be used in a standardization document shall be avoided. The use of tables to translate the specific inch-pound units to metric units is acceptable. For text material, when preference is given in the standardization document to inch-pound units, acceptable metric units may be shown in parentheses. When preference is given to metric units, inch-pound units may be omitted or included in parentheses. In general, where it has long been standard practice to cite metric units alone (such as citing temperatures only in degrees Celsius), inch-pound equivalents may be omitted. A specific repetitive equivalent (for example, 2.5 inches (63.5 mm)), need be inserted only the first time it appears in each paragraph of a standardization document.

6.0. List of Existing Metric Practice Documents*

Ambs, H. D. (SCM Corp., Johnstown, PA, "Practical Metrication for P/M, International Journal of Powder Metallurgy and Powder Technology; January 1978; v. 14, no. 1: pp 57-62.

American Society of Mechanical Engineers, "General Tolerances for Metric Dimensioned Products": ASME; 1984; B4.3-78, 8 pages.

American Society of Mechanical Engineers, "Guide for Metrication of Codes and Standards SI (Metric) Units; 1981; SI-9-81. 43 pages.

Metric Practice Guide - Welding Handbook. 8th ed.: American Welding Society, Inc. 47 pages

American Welding Society, Inc. "Metric Practice (Welding Inspection)": American Welding Society, 13 pages.

Aerospace Industries Association of America, Inc. "NA Documents Preparation and Maintenance in SI (Metric) Units" (Rev. 1): AIA/NAS; 1977; NAS 10000-77. 13 pages.

American Society of Mechanical Engineers. "Preferred Metric Limits and Fits": ASME; 1984; B4.2-78. 70 pages.

Aerospace Industries Association of America, Inc. "Preferred Metric Units for Aerospace" (Rev. 2): AIA/NAS; 1985; NAS 10001-85. 23 pages.

Electronic Industries Association. "Recommended Practice for Dual Dimensioning": EIA; 1976; JEP86-A-76. 46 pages.

Institute of Electrical and Electronics Engineers. "Recommended Practice for Preferred Metric Units for Use in Electrical and Electronics Science and Technology": IEEE; 1984; 945-84, 34 pages.

Society of Automotive Engineers. "Rules for SAE Use of SI (Metric) Units, Recommended Practice": SAE; May 1985; J916-85.

Society of Automotive Engineers. "Standard Dual Dimensioning": SAE; June 1982; J 390-82.

American Society for Testing and Materials. "Standard for Metric Practice": ASTM; 1989; E380-89. 42 pages.

Institute of Electrical and Electronic Engineers. "Standard Letter Symbols for Units of Measurement" (SI Units, Customary 'Inch-Pound' Units, and Certain Other Units): IEEE/ANSI; 1985; 260-78. 24 pages.

Institute of Electrical and Electronics Engineers. "Standard Metric Practice": IEEE; 1982; 268-82, 49 pages.

American Association of State Highway and Transportation Officials. "Standard Metric Practice Guide" (ASTM E380): AASHTO; R 1-77. 40 pages.

American Society for Testing and Materials. Standard Practice for the Use of Metric (SI) Units in Building Design and Construction" (Committee E-6 Supplement to E 380): ASTM; 1984 E621-84. 38 pages.

American Society for Testing and Materials. "Standard Guide for Selection of Scales for Metric Building Drawings": ASTM; 1988; E713-88. 3 pages.

National Fluid Power Association. "Survey on Metric Language Usage by the US Fluid Power Industry": NFPA; 1977; T2.10.2-77. 25 pages (appendices X and Y).

American Society of Heating, Refrigerating, and Air Conditioning Engineers. "Units and Conversions" (ASHRAE Handbook - Fundamentals SI): ASHRAE; 1985; CH37-85. 2 pages.

American Society of Agricultural Engineers. "Use of SI (Metric) Units": ASAE; 1988; EP285.7-88. 8 pages.

Society of Automotive Engineers. "Handbook of Hydraulic Metric Calculations": SAE; 1981; AIR 1657-81. 24 pages.

Society of Automotive Engineers. "Limits and Fits - International Metric Tolerance Systems": SAE; 1982; AIR 1758-82. 14 pages.

American Petroleum Institute. "Manual of Petroleum Measurement Standards" Chapter 15 - Guidelines for the Use of the International System of Units (SI) in the Petroleum and Allied Industries: API; 1987; MPMS 15-80 or PUBL 2564-80. 44 pages.

Association for Information and Image Management. "Guidelines for Metrics": AIIM; 1989; AIIM TR1-1988. 21 pages.

Interagency Committee on Metric Policy. "Preferred Metric Units for General Use by the Federal Government": General Services Administration; 1983; FED-STD-376A.

American National Metric Council: "Metric Editorial Guide" (Rev. 4): ANMC; 1985; ANMC-85-1.

National Bureau of Standards. "The International System of Units (SI)": NBS; 1986; NBS Special Publication 330. 48 pages.

Department of Defense, DOD-STD-1690, Maritime Metric Practice Guide, 30 May 1979. 36 pages.

ISO 1000, "SI Units and Recommendations for the Use of Their Multiples and Certain Other Units": 1981; International Organization for Standardization.

U.S. Department of Commerce. Federal Register Notice, "The Metric System of Measurement", in the Federal Register, February 26, 1982 (in NBS Letter Circular LC 1132).

* These are the latest known versions; later revisions may have been issued or are underway.

U S GOVERNMENT PRINTING OFFICE 1990 - 706-271